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सतही/जमीन के नीचे के  
हाइड्रोइलेक्ट्रिक पावर स्टेशनों की  
जल निकासी और निर्जलीकरण  
हेतु रीति संहिता  
( दूसरा पुनरीक्षण )

**Code of Practice for Drainage  
and Dewatering of Surface/  
Underground Hydroelectric  
Power Stations**  
( *Second Revision* )

ICS 17.120.20

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## FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Hydroelectric Power House Structures Sectional Committee had been approved by the Water Resources Division Council.

Drainage of hydroelectric power stations requires special considerations. General drainage provisions as stipulated in IS 1742 : 1983 'Code of practice for building drainage (*second revision*)' and IS 1172 : 1993 'Code of basic requirements for water supply, drainage and sanitation (*fourth revision*)' shall also apply for hydroelectric power stations. However, there are some features peculiar to hydroelectric power stations only which are dealt with in this standard.

This standard was first published in 1968 and revised in 2000. The current revision is undertaken to reflect the experiences gained in the field since its last revision. In this revision apart from updating provisions in general, additional provisions relating to drainage sumps and pumps have been incorporated.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# CODE OF PRACTICE FOR DRAINAGE AND DEWATERING OF SURFACE/UNDERGROUND HYDROELECTRIC POWER STATIONS

( *Second Revision* )

## 1 SCOPE

**1.1** This standard stipulates requirements for drainage and dewatering arrangements for water discharges for surface/underground hydroelectric power station.

**1.1.1** The general drainage of the power house building shall, however, be done in accordance with IS 1742 and IS 1172 except that some special features peculiar to a power house building have been dealt in this standard.

## 2 REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

<i>IS No.</i>	<i>Title</i>
554 : 1999	Pipe threads where pressure-tight joints are made on the threads — Dimensions, tolerances and designation ( <i>fourth revision</i> )
778 : 1984	Specification for copper alloy gate, globe and check valves for water works purposes ( <i>fourth revision</i> )
1172 : 1993	Code of basic requirements for water supply, drainage and sanitation ( <i>fourth revision</i> )
1239 (Part 1) : 2004	Steel tubes, tubulars and other wrought steel fittings — Specification : Part 1 Steel tubes ( <i>sixth revision</i> )
1742 : 1983	Code of practice for building drainage ( <i>second revision</i> )
3589 : 2001	Steel pipes for water and sewage (168.3 to 2 540 mm outside diameter) — Specification ( <i>third revision</i> )
14846 : 2000	Sluice valves for water works purposes (50 to 1 200 mm size) — Specification

## 3 DRAINAGE AND DEWATERING SYSTEMS

**3.1** The various systems suitable for power house building may be classified as:

- a) gravity drainage system,
- b) pressure drainage system, and
- c) dewatering system.

## 4 GRAVITY DRAINAGE SYSTEM

### 4.1 General

This system includes floor drains, leakage water from penstock coupling, generator coolers, water mist fire extinguishing system for generator (if provided), scroll case liner, turbine cover, transformer coolers, drainage from formed drains at expansion/contraction joints, compressor cooling water, air conditioning cooling water, ventilation cooling water (for underground power house), hydrant firefighting systems and for other discharges intermittent in character. The drained water is led into either of the following:

- a) Tailrace or a drainage pipe laid outside the power house building as may be convenient, or
- b) A sump within the power house building from which the water is pumped either to the tailrace or to a drainage pipe as given in (a) above.

**4.1.1** It may, at times, be desirable to adopt both the alternatives given in **4.1** in any power house building to keep the amount of pumping from the sump, at minimum.

### 4.2 General Principles of Design

**4.2.1** All walls in contact with water shall have drainage trenches along their interior faces with a suitable floor drain. These include outside walls with backfill against them and which are below annual high tail water level.

In case of underground power station these also include seepage water from side rocks and roof.

**4.2.1.1** Drains shall also be provided to take care of

surface condensation, where likely, on pipe lines. Drainage trenches shall, preferably avoid crossing expansion joints, wherever it is unavoidable, proper seals, around the drainage trench, shall be embedded to prevent entry of drainage water into the expansion joint.

**4.2.2** Oil storage and purifier rooms shall have drains, with gravel pockets, of sufficient capacity to carry the flow from the sprinkler system.

**4.2.3** Drainage from the battery room floor and sink shall have a minimum slope 1 in 50, shall have no pockets or traps and shall discharge directly into the tailrace or the collection gallery (in case of underground power station). The battery room shall preferably be located above the highest water level of tailrace or collection gallery.

Suitable measures shall be taken to dilute the acid sufficiently in case it is discharged into drainage sump.

**4.2.4** Drainage from formed drains of expansion or contraction joints shall discharge into the gravity drainage system.

**4.2.5** Drainage line to a main drainage header or sump shall be provided with suitable traps to prevent escape of odours. The discharge into the sumps shall be below the low water level to reduce noise. The vertical downspout in the sump shall have a 20 mm vent hole above maximum sump water level to prevent air lock. Vertical drains discharging into floor drains on lower floors need not be provided with traps.

**4.2.6** All embedded pipes in the drainage system may be of mild steel or welded steel or any other suitable material. Horizontal lines shall have a slope 1 in 50 if practicable, with a minimum 1 in 100. No drain line shall be less than 100 mm in diameter except for short, sharply sloped runs with few bends from sinks or small pits and battery room, which may be 50 mm in diameter.

NOTE — Slopes mentioned in **4.2.6** do not apply to the main drainage header, if provided.

**4.2.7** Whenever embedded pipes cross expansion or contraction joints, a socket/collar caulked with OAKUM, but not lead, shall be provided in the plane of the joint to permit minor movements without damage.

**4.2.7.1** Pipes crossing construction joints between first and second stage concrete shall be long enough to prevent their choking during second stage concreting. Open end of pipes shall be closed with blank flange.

**4.2.8** Floor drains projecting above the sub-floor shall be installed when the floor finish is laid.

**4.2.9** For surface and underground power stations

transformers shall have a suitable pit below it filled with gravel for the purpose of drainage of the hot, burning oil of the transformer to the oil sump. Suitable fire trap shall be provided to quench the fire of the burning oil (*see* Fig. 1 for typical diagram on fire trap).

### 4.3 Drainage Sumps and Pumps

**4.3.1** Drainage sump shall have sufficient volume to handle seepage through walls, roof, structural cracks, and contraction joints as well and wastewater from equipment as indicated in **4.1**. It shall also include rain and snow water from roofs and decks if not led directly to tail water by gravity. Estimating seepage through contraction joints and walls is usually the major uncertainty in estimating total drainage facility requirements and shall be estimated carefully.

**4.3.2** In surface type powerhouse generally 1 litre/min seepage may be assumed for every 6 m<sup>2</sup> of submerged wall. In case of underground powerhouses this seepage is the function of water table in the hill mass, permeability of the rock-mass and extent of grouting. The estimation of the seepage in underground powerhouse should be backed by analytical methods. One of the simplified methods to estimate the same is by considering the powerhouse as equivalent circular drain/relief well in surcharged medium.

**4.3.3** Drainage sump shall have sufficient volume to permit a minimum 3 min running of the sump pump during each cycle of the operation. Minimum two deep well type sump pumps in working order are preferred, each having a capacity of at least 150 percent of the expected seepage discharge plus 100 percent of the continuous discharge from other sources. Float control or electrical pickup arrangement causes the respective pumps to operate as required with the second pump coming in operation when the first pump fails to handle the inflow. The control panel of the above devices alongwith their signal indicators shall be provided either in the control room or on the turbine generator panel in the machine hall at a level higher than the highest flood level. An alarm indicator may also be provided to function when the maximum allowable high water level in the pump reached.

**4.3.4** Provision of diesel generator (DG) sets should also be made to operate the pumps in exigency of power failure. This shall be located outside the power plant building. Operation of pumps by DG sets shall be checked at fortnightly.

## 5 PRESSURE DRAINAGE SYSTEM

**5.1** The pressure drainage system is independent for each unit of the powerhouse. It conducts cooling water from the bearings, generator, transformer and ventilation cooler of each unit to various outlets above maximum

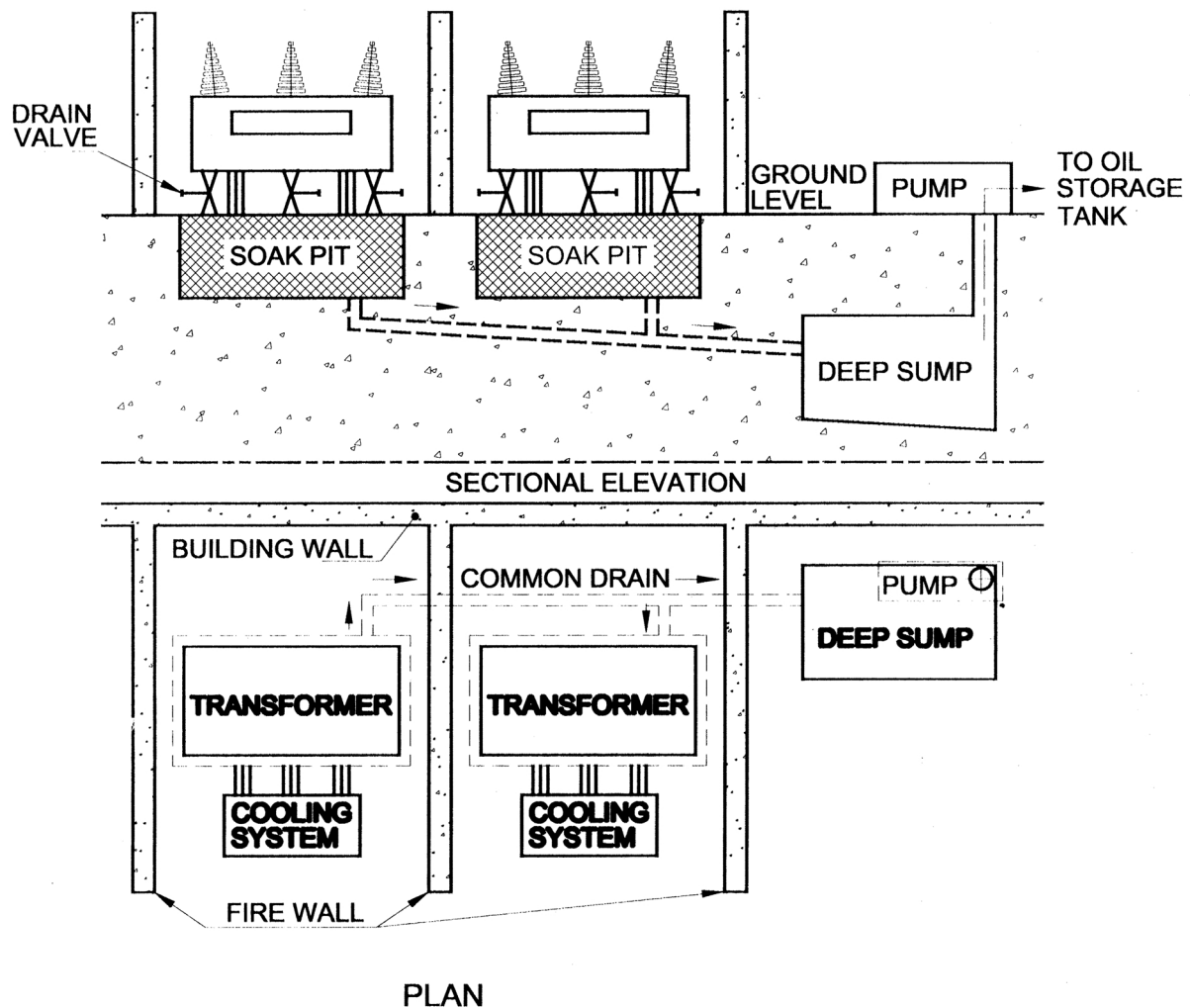


FIG. 1 TYPICAL TRANSFORMER OIL DRAINAGE SYSTEM TO PREVENT FIRE AND BURNING OF OIL

tail water level. This system is subject to the losses in pipes and is designed to run full at all times.

In case of underground power houses, cooling water shall be discharged into draft tube directly.

NOTE — The detailed layout of the system is provided by the designer of the power station in consultation/coordination with the supplier of the equipment.

**5.2** The pipes for pressure drainage system may be mild steel or welded steel pipes. These along with other fittings shall be capable of withstanding the expected pressure, including water hammer where applicable. The steel pipes and fittings shall conform to IS 554, IS 1239 (Part 1). The welded steel pipe shall conform to IS 3589. The valves shall conform to IS 778, IS 14846.

**5.2.1** At the time of installation of embedded pipes and fittings, it shall be ensured by testing or otherwise that the joints in the pipes and fittings are leak-proof against maximum expected pressure (1.5 times design

pressure). Pipes of maximum length shall be used to minimize the number of joints.

## 6 DEWATERING SYSTEM

**6.1** The general principles of design for dewatering the penstock, scroll case, draft tube and discharges into a tailrace or collection gallery through embedded pipes are given in 6.2 and 6.3.

### 6.2 Penstock and Scroll Case Drain Pipe

**6.2.1** The penstock head gate shall be fully lowered and then the penstock and scroll case shall first be dewatered to tail water elevation. This may be achieved in two ways:

- by opening the turbine gate and allowing the water to flow into draft tube, or
- by keeping the turbine gates closed, water may be allowed to flow into draft tube through a separate dewatering line.

NOTE — Where turbine inlet valve is provided and it is not considered necessary to dewater the penstock the turbine inlet valve may be closed instead of lowering the penstock head gate.

**6.2.1.1** The balance water in the penstock and scroll case is then drained below tail water level and draft tubes emptied of water to its bottommost level, after ensuring that the draft tube gates are fully lowered and seals working, by any of the following methods:

- By providing independent dewatering line into the dewatering sump for each individual unit; or
- By providing a common header carrying discharge from each unit to the dewatering sump; or
- By closed circuit dewatering system having dry type dewatering sump (*see* Fig. 2 for typical diagram).

NOTE — System mentioned at (c) has the advantage over the (a) and (b) system that there is absolutely no possibility of flooding during dewatering.

**6.2.2** The penstock or scroll case drain pipe shall be designed to dewater the scroll case and penstock into draft tube below tail water level including head gates leakage. The likely leakage would be evaluated considering the leakage from gates and other sources in water conductor system.

A gate valve for drainage of penstock and scroll case shall be provided in a vertical line, if possible and line

from the case to the valve shall be as short and as direct as possible to prevent clogging by silt. It may also be desirable to provide connections for an air hose to be used to break up the silt, or to provide drain valves in the valve bonnet and at the bottom of the slot. Drains shall take off at the lowest point of the invert.

**6.2.3** Spiral cases which are preceded by a penstock valve, such as butterfly valve, require an air and vacuum relief valve to permit dewatering and filling. This valve shall be of a size that will pass sufficient air to prevent pressure falling below one half of the atmospheric pressure inside the casing during dewatering and will open and release air when under maximum forebay pressure. Air relief vents shall take off at the top of the casing.

**6.2.4** The dewatering take off from scroll case or penstocks shall have cast steel cut off valves placed as close as possible to the casing to provide a safe positive means of shutting off the water in case of emergency.

### 6.3 Draft Tube Drain Pipes

Each draft tube drain pipe under normal tail water shall discharge not less than one-half of one percent of the rated turbine discharge to aid in sealing the draft tube bulkhead gates. The pipe shall be capable of removing one-tenth of one percent of the rated turbine discharge for leakage through the draft tube bulk head gates after sealing with the water level at the floor of the draft

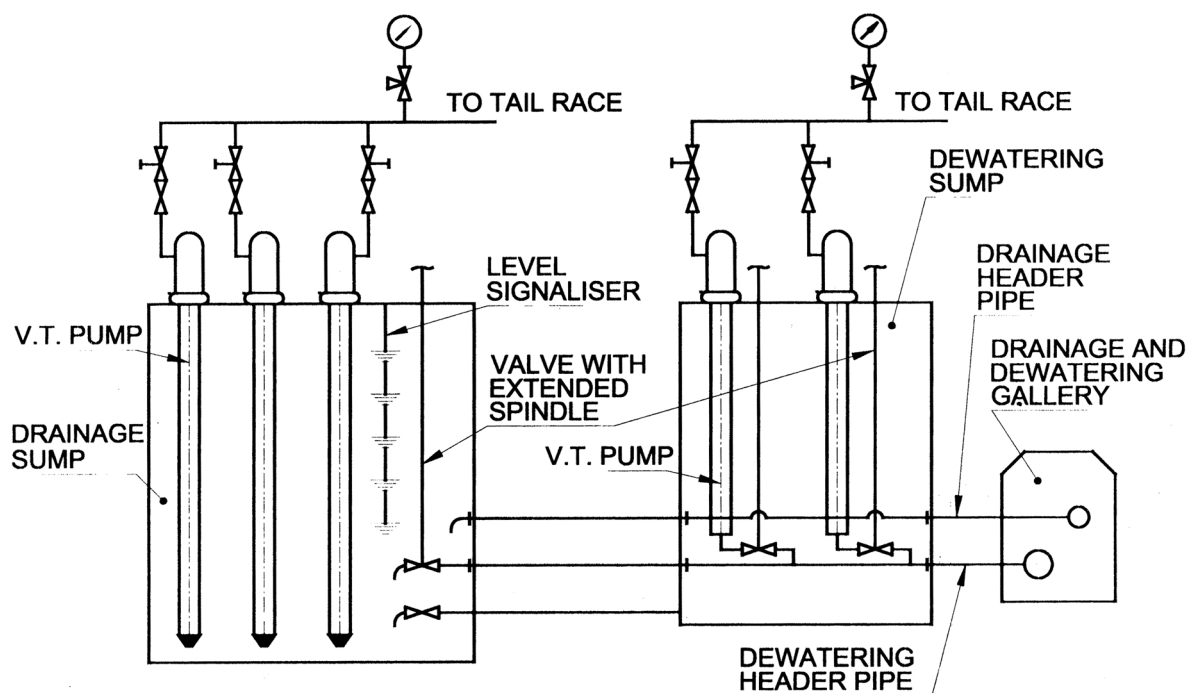


FIG. 2 TYPICAL DIAGRAM OF CLOSED CIRCUIT DEWATERING SYSTEM

tube. Silting of the pipe from the draft tube to the valve shall be guarded against by providing compressed air connection. The discharge from the draft tube drain pipes is carried into the dewatering sump either through independent headers, or through a common header.

#### **6.4 Dewatering Sump and Pumps**

It is desirable to provide minimum of two dewatering pumps in working condition. The sump size and float control shall be designed for a minimum of 3 min running time per cycle. The inflow is determined by the size of the dewatering line from the draft tube. The dewatering header may be connected to the drainage sump through a gate valve to dewater excessive drainage (*see* Fig. 2).

#### **6.5 Dewatering Pipes**

**6.5.1** The dewatering pipes, for the penstocks or scroll case as well as the draft tube and the header, for dewatering the sump are low pressure lines and may be of mild steel, welded steel or any other suitable material. Welded steel duly painted with antirust paints (inside and outside) shall be preferred.

**6.5.1.1** Socket/collar similar to that mentioned in **4.2.7** shall be provided wherever the pipe crosses expansion or contraction joints.

**6.5.2** The pipes and fittings from upstream and including the shut off valve shall be suitable for the maximum expected pressure including water hammer as in the case of pipes for the pressure system.





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### Amendments Issued Since Publication

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